FOREST SERVICE MANUAL
NORTHERN REGION (REGION 1)
MISSOULA, MT

FSM 2500 – WATERSHED AND AIR MANAGEMENT

CHAPTER 2550 – SOIL MANAGEMENT

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New Document	2550	08 Pages
Superseded Document(s) by Issuance Number and Effective Date	2500-99-1 (11/12/1999)	08 Pages

Digest:

2554.03 – Adds new direction to allow units to revise soil quality standards through the land management plan revision process. All other direction remains the same.

2554 - SOIL QUALITY MONITORING

2554.02 – Objectives

To meet direction in the National Forest Management Act of 1976 and other legal mandates. To manage National Forest System lands under ecosystem management principles without permanent impairment of land productivity and to maintain or improve soil quality.

2554.03 – Policy

Design and implement management practices that maintain or improve soil quality. Protection of the soil resource should be emphasized; restoration practices should be implemented where necessary. Soil quality is maintained when erosion, compaction, displacement, rutting, burning, and loss of organic matter are maintained within defined soil quality standards.
Design new activities that do not create detrimental soil conditions on more than 15 percent of an activity area. In areas where less than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 15 percent. In areas where more than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.

> **The mere analysis of soils, no matter how comprehensive or sophisticated, does not provide a measure of soil quality or health unless the (indicators) are calibrated against designated soil functions.**
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> **(Janzen et al 1992. Twenty-eighth Annual Alberta Soil Science Workshop Proceedings. D.R., Bennett, Editor, Land Evaluations Reclamation Branch, Alberta Agriculture, Lethbridge, Alberta, 1991. 363 pp)**
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> **Assessments (of soil productivity) must consider specific soil functions (FSM 2550.5) being evaluated in their land use and societal contexts. Threshold values for key indicators must be established with the knowledge that these will vary depending upon land use, the specific soil function of greatest concern, and the ecosystem or landscape within which the assessment is being made.**
>
> **(Doran, John W. and Parkin, Timothy B., 1996. Quantitative Measures for Soil Quality: a Minimum Data Set, In: Methods for Assessing Soil Quality, SSSA Special Pub Number 49, 1996 p. 33)**

> **Soil services (what soils do for us) and soil functions (how they do it) are fairly universal. However, soils and their properties and processes (attributes) vary greatly, which requires site-specific selection of indicators for monitoring the most important soil functions for a given soil type and disturbance activity. Furthermore, some soils are more resistant to impact than others; a given impact may be detrimental to one soil and have no effect on another.**
>
> **(Burger, Gary and Scott, Using Soil Quality Indicators for Monitoring Sustainable Forest Management, USDA Forest Service Proceedings RMRS-P-59 2010 Scientific Background for Soil Monitoring on National Forests and Rangelands; workshop proceedings RMRS-P-59 2010. p. 28)**

An approach for assessing or monitoring soil quality or productivity needs to be based on a logical link among soil function, properties and indicators.

> **Ultimately selection of indicators for a given forest type and land region must be done by scientists and practitioners with expert knowledge of specific forest ecosystems, forestry operations and forest response to disturbances.**
>
> **(Burger, James A., Gray, Garland, and Scott, D. Andrew; 2010. Using Soil Quality Indicators for Monitoring Sustainable Forest Management, In: Scientific Background for Soil Monitoring on National Forests and Rangelands; workshop proceedings RMRS-P-59 2010. p. 28)**

This concept can be applied to grassland and shrubland soils and management, as well as forest soils and management. There is a large body of research literature on soil/site effects which the local expertise can use in their selection of indicators.

Often there are one or more limiting soil factors that negatively affect a soil function. In order to facilitate the tie between soil functions and site-specific soils, units may identify their common limiting factors and establish soil quality standards that replace the R1 FSM standards during the revision of a land management plan. These soil quality standards:

1. Must assure compliance with National Forest Management Act and Multiple Uses Sustained Yield Act productivity requirements.
2. Address the definition of Soil Productivity found in FSM 2550.5.

3. Must incorporate best available scientific information for selecting productivity indicators, identifying desired condition of the soil, assessing current condition, analyzing management effects, and monitoring.
4. Must have a clear relationship to soil functions that support productivity (see FSM 2550.5).
5. Should use established scientifically supported protocols for assessment, analysis and monitoring, such as the Forest Soil Disturbance Monitoring Protocol (GTR WO-82 a and b) or Interpreting Indicators of Rangeland Health (Tech Reference 1734-6).
6. Address unique soils and ecosystems.

These new soil quality standards should be applicable at the project level, but may also replace the rule set for the Watershed Condition Class attribute 7.1 Soil Productivity. (2010. Watershed Condition Classification Technical Guide FS pub 977 p. 29)

The new soil quality standards may form the basis for project and/or forest plan level monitoring.

2554.04 - Responsibility

1. Regional Foresters

    a. Develop Regional Soil Quality Standards.

    b. Coordinate with Research in the selection of suitable methods for monitoring soil disturbances.

    c. Review Forest soil quality monitoring plans for technical adequacy and to ensure coordination within the Region.

    d. Review soil quality monitoring results for application to other areas and for coordination with Research efforts.

2. Forest Supervisors

    a. Ensure that Forest-wide and project-level plans include soil quality standards.

    b. Assess the extent to which soil quality standards are being met and whether they are effective in maintaining or improving soil quality.

    c. Provide training in the application of soil quality standards.

    d. Evaluate the effectiveness of soil quality standards and recommend adjustments to the Regional Forester.

    e. Report monitoring results to the Regional Forester.

3. District Rangers

a. Ensure that project planning documents identify measures necessary to meet soil quality standards.

b. Conduct post activity implementation monitoring to determine if soil quality standards have been met. Consult with soil scientists to evaluate the need to adjust management practices or apply rehabilitation measures.

2554.1 – Monitoring

Management activities create various amounts of soil disturbance, but ecologically sustainable land stewardship can minimize adverse impacts on soils. Soil quality standards provide benchmark values that indicate when changes in soil properties and soil conditions would result in significant change or impairment of soil quality based on available research and Regional experience (Page-Dumroese et al. In Review). Proper application of these standards requires professional knowledge and judgement.
Soil quality standards apply to lands where vegetation and water resource management are the principal objectives, that is, timber sales, grazing pastures or allotments, wildlife habitat, and riparian areas. The standards do not apply to intensively developed sites such as mines, developed recreation sites, administrative sites, or rock quarries. They are not intended to prohibit other resource management practices such as, installing waterbars or preparing sites for planting, as long as such practices are consistent with long-term sustainability of the soil resource. Permanent roads do affect soil-hydrologic function, however, their evaluation is more appropriately done on a watershed basis using models and other watershed analysis techniques.

1. Detrimental Soil Disturbance. These disturbances includes the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement. At least 85 percent of an activity area must have soil that is in satisfactory condition. Detrimental conditions include:

Compaction. Detrimental compaction is a 15 percent increase in natural bulk density. The cumulative effects of multiple site entries on compaction should also be considered since compacted soils often recover slowly.

Rutting. Wheel ruts at least 2 inches deep in wet soils are detrimental.

Displacement. Detrimental displacement is the removal of 1 or more inches (depth) of any surface soil horizon, usually the A horizon, from a continuous area greater than 100 square feet.

Severely-burned Soil. Physical and biological changes to soil resulting from high-intensity burns of long duration are detrimental. This standard is used when evaluating prescribed fire. Guidelines for assessing burn intensity are contained in the Burned-Area Emergency Rehabilitation Handbook (FSH 2509.13).

Surface Erosion. Rills, gullies, pedestals, and soil deposition are all indicators of detrimental surface erosion. Minimum amounts of ground cover necessary to keep soil loss to within tolerable limits (generally less than 1 to 2 tons per acres per year) should be established locally depending on site characteristics.

Soil Mass Movement. Any soil mass movement caused by management activities is detrimental.

2. Organic Matter Guidelines. The loss of surface organic matter can cause nutrient and carbon cycle deficits and negatively affect physical and biological soil conditions. Objectives for fine organic matter layer thickness and distribution should be determined locally based on similar soils or ecological types. The direct benefits of coarse woody material to soils can vary widely, depending on ecological type. Research guidelines such as those contained in Graham et al. 1994, should be used if more specific local guidelines are not available. Since the management of coarse woody material is important to wildlife, fire, and other resources, integration based on local objectives needs to occur.

3. Monitoring Methods. Visual methods are generally used to make initial evaluations of the effects of management activities on soils. The major objective of soil quality monitoring is to ensure that ecologically sustainable soil management practices are being applied. In most cases, qualitative estimates will be considered sufficient. The use of photo points provides good documentation and is recommended. Measurements and detailed sampling are used to calibrate visual methods and to conduct investigations where visual methods are inadequate or where benchmark or statistically valid sampling is required.

a. Areal Extent Sampling. Estimates of the percent of an activity area affected by detrimental soil disturbance can be made visually or by transecting. If statistically valid techniques are needed for benchmark sites, determine sample size and transect design using procedures described in Howes, Hazard, and Geist 1983.

b. Soil Sampling Techniques. Soil displacement, rutting, severely burned soil, erosion, mass movement, and above-ground organic matter can be observed and measured.

Soil compaction can be assessed by observing management-induced platy structure or by evaluating changes in bulk density, macroporosity, or penetration resistance using appropriate methods. Tile spade estimations of soil compaction are very effective and can be calibrated with soil strength (Clayton 1987). Root-restricting bulk densities for various soil particle-size classes are displayed in the National Soil

Survey Handbook, 618.06. These bulk density values can also be used as indicators of detrimental soil compaction.

Randomly located samples should be taken prior to soil disturbance to estimate the natural bulk density, penetration resistance, infiltration rate, or soil structure. If the site has been previously disturbed, an adjacent area with similar soils can be sampled.

DEFINITIONS

Activity Area. A land area affected by a management activity to which soil quality standards are applied. Activity areas must be feasible to monitor and include harvest units within timber sale areas, prescribed burn areas, grazing areas or pastures within range allotments, riparian areas, recreation areas, and alpine areas. All temporary roads, skid trails, and landings are considered to be part of an activity area.

Bulk Density. The mass of dry soil per unit volume, corrected for weight and volume of coarse fragments greater than 2mm in diameter.

Compaction. A physical change in soil properties from compression, vibration, or shearing that increases soil bulk density and decreases porosity, air exchange, root penetration, infiltration, and permeability.

Coarse Woody Material. Organic materials on the soil surface such as plant stems, branches, and logs with a diameter greater than 3 inches.

Detrimental Soil Condition. The condition where established soil quality standards are not met and the result is a significant change in soil quality.

Displacement. The removal and horizontal movement of soil from one place to another, usually by mechanical forces such as dozer blades, repeated vehicular traffic, or the yarding of logs.

Fine Organic Matter. Organic materials such as plant litter, duff, and woody material less than 3 inches in diameter in contact with the soil surface.

Ground Cover. Ground cover consists of vegetation, fine organic matter, coarse woody material, and rock fragments larger than three-fourths inch in diameter in contact with the soil surface.

Hydrologic Function. Soil hydrologic function is the ability of the soil to absorb, store, and transmit water, both vertically and horizontally. Changes in soil bulk density, soil structure, and ground cover can alter the hydrologic function of the soil.

Restoration. Treatments that restore vital soil functions to their inherent range of variability. It is recognized that treatments may need to occur over a period of years and may need to be maintained. Restoration treatments could include, but are not limited to, tillage, ripping, seeding, mulching, recontouring if temporary roads, and water barring.

Rutting. Deformation of the soil under saturated conditions resulting in detrimental changes to soil structure and reduced porosity.

Soil Function. Primary soil functions are: (1) the sustenance of biological activity, diversity, and productivity, (2) soil hydrologic function, (3) filtering, buffering, immobilizing, and detoxifying organic and inorganic materials, and (4) storing and cycling nutrients and other materials.

Soil Mass Movement. The detachment and downslope movement of soil or the surface mantle in the form of debris slides/avalanches or deep-seated rotational failures or slumps.

Soil Quality. The capacity of a specific soil to function within its surroundings, support plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation.

Surface Erosion. The detachment and transport of individual soil particles by wind, water, or gravity. Surface erosion is the loss of soil in a fairly uniform layer across the land surface (sheet erosion), in many small rills, or as larger gullies.

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